REMARKS:

1) Entry and consideration of this Response after Final are respectfully requested. This Response does not introduce any new amendments or any new/additional claims. Also, the present remarks are directly responsive to the new grounds of rejection that were asserted for the first time in the Final Office Action. Thus, this is applicants' first opportunity to reply to the new grounds of rejection. The present Response does not raise any new issues that would require further search and consideration, beyond the issues of the Final Office Action. Accordingly, entry and consideration of the present Response after Final are appropriate, and are respectfully requested.

2) Referring to section 6 on pages 2 to 8 of the Office Action, the rejection of claims 1, 2, 10 to 14 and 17 to 19 as obvious over Applicant's Admitted Prior Art (AAPA) in view of US Patent 6,512,575 (Marchi) is respectfully traversed.

3) Before particularly addressing this prior art rejection and comparing the claimed features to the prior art disclosures, the invention will first be discussed in general terms to provide a background.

Generally, the invention is directed to a method of calibrating a 3D image sensor comprising a receiving array having a plurality of receiving pixels. It is significant that the invention involves such a <u>3D image sensor</u> with a <u>plurality of receiving pixels</u>, because <u>these individual pixels are all</u>

<u>individually adapted to generate their own individual received signal respectively representing</u> **<u>one image pixel of the image of the viewed scene</u>** that is sensed and recorded by the sensor based on the <u>radiation that is **reflected** from the viewed scene onto the pixels of the sensor</u> (see the present specification at page 1 lines 14 to 19, page 2 line 23 to page 3 line 10). Thus, each individual pixel of the receiving array does not "see" the entire image of the viewed scene, but rather <u>each receiving pixel of the receiving array merely "sees" one image pixel of the overall viewed scene</u>, whereby all of the image pixels together make up the overall viewed scene. Then, by individually determining a relative distance measurement for each receiving array pixel, from the receiving pixel to the image pixel of the viewed scene being recorded by that particular receiving pixel, the resultant relative distance measurements for all of the individual pixels together will provide a three dimensional image information. Namely, the 2-D receiving array has a 2-D configuration to "see" and record a 2-D grid pattern of image pixels, and the respective distance measurement of each respective receiving pixel gives the third dimension of depth or distance for the image points or image pixels. As will be discussed below, the Marchi patent reference does not relate to such a 3D image sensor.

Furthermore, and more importantly, while the present invention relates to a method of "calibrating" the 3D image sensor, and the Marchi reference also relates to a method of "calibrating" a light detecting device such as a photodiode, <u>the type and meaning of the "calibrating" is very different in the</u>

present invention in comparison to the Marchi reference. In the present invention, "calibrating" refers to detecting or determining and then compensating distance-related, pixel-individual, relative differences among the plural receiving pixels (see the specification at page 2 line 23 to page 3 line 10). Namely, due to different processing or fabrication tolerances, different temperature variation characteristics, and/or different aging processes, the plural individual receiving pixels in a receiving array may have respective individual output characteristics that deviate from one another to different degrees (specification page 2 lines 11 to 17). The object of the present invention is to "calibrate" the various pixels relative to each other or relative to a nominal standard by determining the pixel-individual output differences and compensating these pixel-individual differences so that the compensated output of each one of the individual receiving pixels is the same for all of the pixels when substantially the same phase input is applied to all of the pixels. This "compensating" relates to the output behavior of the individual pixels relative to one another, and does not involve "calibrating" the receiving array to achieve an accurate distance measurement based on a specified known target distance. In other words, the actual distance from the receiving array to the viewed scene or target image is not relevant to the present invention. For example, all of the individual receiving pixels could be "calibrated" relative to each other according to the present invention, yet still not be properly "calibrated" for an accurate distance measurement, and thus might give an incorrect absolute distance measurement result despite being

inventively "calibrated" relative to one another to ensure the "relative correctness" of the several distance measurements respectively of the several receiving pixels. Particularly, for example, the compensation involves adjusting one or more modulation perimeters of each individual pixel so that all of the receiving pixels exhibit the same output characteristic behavior relative to one another for a given substantially uniform input applied to all of the receiving pixels.

On the other hand, the Marchi patent reference relates to a "calibration" to achieve absolute accuracy or correctness of an actual distance measurement, and <u>does not have anything to do with relatively "calibrating" several receiving pixels relative to one another</u>. In other words, unlike Marchi, in the present invention an individual pixel is not subjected to a calibration to achieve an accurate distance measurement, but rather all of the pixels are compensated relative to one another, so that the compensated output signals of the pixels will give the same compensated output values for substantially the same phase inputs, without an actual distance calibration being carried out. So, while the compensated outputs of the individual receiving pixels relative to one another will be uniform, the absolute accuracy of the distance measurement provided by the pixels has not been validated or calibrated. The inventive method does not require and does not use a known distance to a target for carrying out the calibration, but rather all of the pixels are simply illuminated with a calibrating radiation that has a phase position which is at least largely homogenous for all of the pixels. Again, <u>it is the uniformity among the pixels that is</u>

<u>important, and not the absolute actual distance between the receiving array and a calibrating target scene</u>.

In the present invention, as discussed above, the distance measurements by the individual receiving pixels of the image sensor are used to provide the image depth information for producing a 3D image. In this regard, the actual absolute distance to the three dimensional object in the viewed scene is not important, but rather only the relative distance of the several image pixels making up the viewed scene, so that the relative distance of the pixels relative to one another represents the proper "three-dimensionality" of the viewed scene or of a 3D object in the scene, without telling accurately how far away this object is in terms of its absolute distance from the image sensor.

4) Present independent claim 1 is directed to a method for calibrating a 3D image sensor.

The 3D image sensor includes a modulated light source emitting a modulated signal into a viewed scene, and <u>a receiving array having a **plurality of receiving pixels** and being adapted to receive detected radiation that is **reflected** from the viewed scene</u>. The <u>receiving array respectively generates a received signal individually for every pixel</u> from the detected radiation that is reflected from the viewed scene and received by the receiving array.

These claimed features highlight significant differences relative to the Marchi patent reference. Marchi discloses a

device and a calibration method with a sensor or detector that is a single individual sensor such as a photodiode (5) and does not include a plurality of individual receiving pixels (see abstract, Fig. 3, col. 11 lines 4 to 12, col. 13 lines 49 to 51, etc.).

The Examiner acknowledges that Marchi does not disclose a sensor or detector including a receiving array of plural receiving pixels. However, the Examiner asserts that it would have been obvious to apply the calibration procedure of Marchi to each pixel in the array of detectors according to the Applicant's Admitted Prior Art (AAPA) "*to ensure the accurate measurements could be obtained from each detector*" (last sentence on page 3 of the Office Action). Firstly that would not have been obvious or suggested by a consideration of the prior art references themselves, and secondly that is not what the inventive method involves (as discussed above).

The single-pixel photodiode detector (5) of Marchi "sees" the entire scene at once, because the detector receives the diffused light signal that is diffused from the scene back to the detector (see abstract, col. 3 line 46, col. 4 lines 9 and 49, col. 11 lines 4 to 12 and 41 to 44 and 53 to 57, col. 13 lines 49 to 51, etc.). Because the device and method according to Marchi operates with diffused light returned from the object or the scene, the light detector "sees" all of the object or scene at once, because it receives the diffused light from the entire scene or target. In such an arrangement and method, it would not have any sense to provide a plurality of individual detectors or pixels, because each detector or pixel would merely have also

seen the entire viewed scene or object. This would merely have been a duplication, but would not have detected individual image pixels that are individually received and recorded by the individual receiving pixels. Because the device and method of Marchi particularly operates with diffused light that is diffused from the target object back to the single detector, there also would have been no way to individually sense or detect individual image pixels with a plurality of individual receiving pixels of a detector array, even if such a plurality of photodiodes (5) of Marchi would have been provided.

For the above reasons, a person of ordinary skill in the art reading and understanding the AAPA and the disclosures of Marchi, would not have been motivated to combine those disparate teachings in the manner now proposed by the Examiner as a reconstruction of the present invention.

Furthermore, because the single detector according to Marchi simultaneously "sees" the entire target object or scene, in order to obtain individual image pixel information, Marchi teaches to <u>scan the illuminating laser beam in a raster pattern across the target object</u>, while the photodiode or detector still views the entire target object and sequentially receives the diffused light from successive image pixels or image points that are successively illuminated by the scanning laser beam along the raster scanning pattern (col. 1 lines 35 to 59, col. 3 line 38, col. 5 lines 26 to 32, col. 8 lines 23 to 34, col. 12 lines 23 to 29, etc.). <u>Such scanning of the illuminating laser beam teaches away from the provision of a receiving array including a plurality of receiving pixels</u>, because the combination of a

scanned illuminating beam with a single photodiode detector already provides the required successively scanned image point data successively along the raster scanning pattern. Therefore, further, a person of ordinary skill in the art would have been motivated directly away from the Examiner's proposed combination of the prior art teachings.

<u>Secondly, as mentioned above, even if the AAPA and the Marchi reference would have been considered in combination, the present invention still would not have been suggested</u>. The Examiner has acknowledged that the AAPA does not disclose calibrating a receiving array as presently claimed. In this regard, the Examiner has applied the Marchi reference because allegedly "*it would be obvious to apply the calibration procedure of Marchi to each pixel in the array in the detectors of AAPA to ensure the accurate measurements could be obtained from each detector*" (last sentence on page 3 of the Office Action). However, as discussed above, the calibration procedure of Marchi is substantially different from the calibration procedure according to the present invention. Namely, the present invention does not involve simply applying an absolute distance calibration of Marchi to each pixel in an array of pixels to ensure that accurate measurements could be obtained from each pixel or detector. In fact, the present calibration method does not ensure that accurate measurements (regarding an absolute distance measurement) can be obtained from each pixel. Instead, the present invention involves detecting pixel-individual deviations of the respective pixels relative to one another.

In this regard, especially see dependent claim 2 which recites "a relative modulation phase deviation between the pixels is detected in the evaluating of the received signals for the calibration". Regarding claim 2, the Examiner has asserted "*AAPA in view of Marchi discloses detecting the relative phase deviation between the pixels (e.g. detecting the phase error for each detector; Marchi c.15, 1.4 - c.16, 1.2)*" (first sentence on page 4 of the Office Action). That assertion is respectfully traversed, because actually Marchi discloses an absolute calibration of a single detector, namely the phase error of a single detector relative to a known absolute target distance (see abstract, col. 4 lines 44 to 63, col. 6 lines 27 to 45, col. 7 lines 9 to 11, col. 11 lines 45 to 61, col. 15 line 59 to col. 16 line 15, etc). Thus, even if a person of ordinary skill in the art would have provided a method and device according to Marchi in a duplicated plural arrangement, namely with plural photodiode detectors (5), the calibration method still would have involved calibrating each one those detectors absolutely with respect to the known target calibration distance, rather than by determining relative pixel-individual deviations among the pixels.

Furthermore, present independent claim 1 recites that the calibration involves a step in which <u>the entire receiving array with its plurality of pixels is exclusively illuminated with a first modulated calibrating radiation having a first phase position of a modulation thereof which is at least largely homogeneous for all of the pixels</u>. Such a step also would not

have been suggested by a combined consideration of the AAPA and Marchi. As discussed above, Marchi uses a single photodiode detector to "see" the entire target object or image at once, or scans the illuminating laser beam across the target object in a raster pattern in order to provide sequential line-by-line image scan data sequentially to the single photodiode detector. If the method and arrangement of Marchi would be duplicated to provide a plurality of photodiode detectors, along the lines of the Examiner's proposed modification, then there still would have been no suggestion that an entire receiving array including plural pixels should be simultaneously illuminated with a calibrating radiation having a first phase position that is largely homogeneous for all of the pixels. Instead, at best, each pixel would have been calibrated individually and successively based on a known reference target distance to achieve an absolute distance calibration as disclosed by Marchi, rather than illuminating the entire receiving array of plural pixels at once with a calibrating radiation that has a largely homogeneous phase position for all of the pixels.

5) Regarding dependent claim 14, this claim further recites that a pixel-individual phase deviation is detected individually for each one of the pixels, and the respective pixel-individual phase deviation is recorded in a look-up table for each pixel individually, and then the respective pixel-individual phase deviation of each pixel is applied for correcting 3D image information of the viewed scene. The Examiner has asserted that Marchi discloses detecting pixel-individual phase differences,

but that assertion is traversed (as discussed above). Marchi does not teach anything about detecting pixel-individual phase deviations relative to one another, or that there even would be relative pixel-individual phase deviations or differences, because the method of Marchi only applies to a single individual photodiode detector. Furthermore, the Examiner has acknowledged that AAPA and Marchi do not disclose storing the pixel-individual phase differences in a look-up table, but the Examiner has taken "Official Notice" that it is well known in the art to store calibration results in a memory. The Examiner is respectfully requested to cite any pertinent prior art that might be known in this regard, particularly relating to the storing in a look-up table of pixel-individual phase deviations of a multi-pixel receiving array and then using the respective pixel-individual phase deviations from the table for correcting 3D image information. Without any such known prior art suggestion, claim 14 would not have been obvious.

6) Independent claim 19 also recites several important distinguishing features of the invention that have been generally discussed above.

In a calibration mode, the inventive method includes a step of <u>illuminating a plurality of pixels of a receiving array with a modulated calibrating radiation having a first phase position of the modulation thereof being essentially homogeneous across all of the pixels</u>. Neither of the applied prior art references has anything to do with such a step. As acknowledged by the Examiner, the AAPA has nothing to do with calibration, and the

Marchi reference only provides and calibrates a single photodiode detector. From such teachings, there would have been no suggestion that a plurality of pixels of a receiving array should all be illuminated together with a modulated calibrating radiation that has a first phase position essentially homogeneous across all of the pixels. Instead, Marchi teaches only to use a known target object distance for calibrating a single photodiode detector. How a plurality of pixels of a receiving array should be calibrated with a single calibrating radiation is not disclosed or suggested.

Further according to present claim 19, the inventive method in the calibration mode comprises <u>determining respective pixel-individual deviations of the demodulated calibration output signals of the several pixels relative to one another or relative to a nominal standard value</u>. Such an evaluation for determining respective pixel-individual deviations is not disclosed or suggested in the prior art as discussed above.

Furthermore, an operation mode of the inventive method according to claim 19 involves <u>compensating the operation output signals or demodulated operation output signals of the pixels of the receiving array based on the respective pixel-individual deviations determined for the pixels in the calibration mode</u>. Such individual compensation of individual pixels relative to one another would not have been disclosed or suggested by the references as discussed above.

7) For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claims 1, 2, 10 to 14 and 17 to 19 as obvious over AAPA in view of Marchi.

8) Favorable reconsideration and allowance of the application, including all present claims 1, 2, 10 to 14 and 17 to 19, are respectfully requested.

Respectfully submitted,

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Transmittal Cover Sheet

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